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# *DODONAEA VISCOSA*: A SYSTEMATIC REVIEW

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**ABSTRACT**
*Dodonaea viscosa* is commonly called as hop seed bush in English and virali in Tamil. It is a common plant of tropical and sub-tropical regions. All the plant parts are medicinally useful but the leaf part has been extensively used. The leaf is also consumed by our ancients in day to day cooking and also to cure various diseases. The plant was found to contain almost all the primary & secondary metabolites and is used in our traditional medicine as anti-diabetic, febrifuge, anti-inflammatory, etc. Hence by viewing the above criteria, the present study aims to prepare a review & cover the entire details of the *Dodonaea viscosa*.

**Keywords**: Phytochemical, Physicochemical, Plant Powder.

## INTRODUCTION

The plant *Dodonaea viscosa* is an easily available plant occurring both as a herb and tree. It is generally grown as a garden tree in many houses. The plant is being used for the treatment of various diseases from ancient times. The current study aims to concise and consolidate the pharmacognostical & phytochemical details of the plant.

## MATERIALS

Earlier works on *Dodonaea viscosa* (L.) Jacq., with reference to literature was collected from Arulmigu kalasalingam college of Pharmacy's library and in various other well-established libraries. The earlier report on Pharmacognostical, phytochemical and pharmacological studies on *Dodonaea viscosa* (L.) Jacq. were listed below.

**Plant profile [1, 2]**
Botanical source: *Dodonaea viscosa* (L) Jacq.
Family : Sapindaceae
Parts used : Bark, leaves & root

**Vernacular Names [3]**
Tamil : Viraali
English : Hopseed bush
Telugu : Bandaru
Marathi : Lutchmi
Malayalam : Aattotta Krali
Hindi : Sanatta Sinatha

**Taxonomical classification**
Kingdom : Plantae
Sub division : Superatophytina
Division : Tracheophyta
Super division : Embryophyta
Class : Magnoliopsida
Order : Sapindales
Family : Sapindaceae
Genus : *Dodonaea*
Species : *Viscosa*

The defatted material was removed from the soxhlet apparatus and air dried to remove the last traces of petroleum ether. The defatted material was subjected to extraction by Ethanol as solvent by soxlet apparatus. The extract obtained with each solvent was weighed and percentage yield calculated.

**Distribution [5]**
*Dodonaea viscosa* (L) Jacq. is believed to be Australia and also naturalized throughout tropical, subtropical and warm

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temperature region of Africa, America, Southern Europe and Asia.

**Plant description [2, 5-7]**

*Dodonaea viscosa* (L) Jacq., is a thin-stemmed, leafy shrub or tree, usually 2-8 meter tall with light crow. Bark is grey, grooved, peeling and branchlets are rusty red and resinous. Leaves are simple, thin, narrow, 5-10cm long, 5-8mm wide with untoothed margins. Leaf tip is round or pointed. Leaves secrete gummy exudate which gives the leaves a shiny appearance.

**Other species**

- *Dodonaea adenophora* Miq.
- Dodonaea amblyophylla Diels
- Dodonaea aptera Miq.
- Dodonaea baueri Endl.
- Dodonaea biloba J G.West
- Dodonaea boroniifolia G.Don
- Dodonaea bursariifolia F.Muell.
- Dodonaea caespitosa Diels
- Dodonaea camfieldii Maiden & Betche
- Dodonaea ceratocarpa Endl.
- Dodonaea concinna Benth.
- Dodonaea coriacea (Ewart & O.B.Davies) McGill.
- Dodonaea divaricata Benth.
- Dodonaea ericifolia G.Don
- Dodonaea ericoides Miq.
- Dodonaea falcate J.G.West
- Dodonaea filifolia Hook.
- Dodonaea filiformis Link
- Dodonaea glandulosa J.G.West
- Dodonaea hackettiana W.Fitzg.
- Dodonaea heteromorpha J.G.West
- Dodonaea hexandra F.Muell.
- Dodonaea hirsuta Maiden & Betche
- Dodonaea hispidula Endl.

**Morphological character**

**Leaves**

Leaves are alternate, exstipulate, simple or abruptly pinnate.

**Flowers**

Flowers are unisexual or polygamodioecious in axillary or terminal racemes, corymbs or panicles, inconspicuous. Sepals 2-5 imbricate or valvate. Disk obsolete in the male, small in the female flowers. Stamens 5-10(usually8), inserted on the outer side of the disk.

Filaments very short, anthers linear-oblong, obtusely 4-gonous, septicall 2-6 valved, valves winged at the back, cells 1-2 seeded.

**Seeds**

The seeds are lenticular or subglobose, compressed, exalbuminous, exarillate, funiocle thickened, testa crustaceous or coriaceous.

**Chemical constituents [1,4,7,8]**

**Bark**

- Flavonoids – Quercetin, isorhamnetin
- Tannins – catechins
- Alkaloids
- Chalcones

**Seeds**

- Fatty acid like stearic, myristic, palmitic, oleic, linoleic acid.
- Protein 8.25 % and content rich in lysine, leucin and sulfo amino acid like methionine.
- Vitamin B1, B2 and Niacin.
- Minerals like Ca, Mg, K, Mn, Fe, P and Zn

**Aerial parts**

- Flavonoid glycoside quercetin, Flavone 3-glucoside viz iso-vitexin, iso-orentine and iso-orentine 3-methyl ether.

**Fruit**

- Cucurbitane type triterpen glycoside viz coloncynthoside A & B.
- Cucurbitane type triterpen glycoside viz cucurbitacin E 2-O-beta-D-glycoside and its aglycone cucurbitacin E.
- 2-O-beta-D-glucopyranosyl-16 alpha- 20R-dihyroxy-cucurbita-1,5,23E,25(26)-teraen-3,11,22-trione
- 2-O-beta-D-glucopyranosyl-cucurbitacin B and 2, 25-di-o-beta-D-glucopyranosyl-cucurbitacin

**Leaves**

- Triterpenoids spinasterol and 22, 23-dihydrospinasterol

**Traditional medicinal uses [1, 4, 9, 10]**

- In the Philippines, decoction of bark used as effective astringent for eczema and simple ulcers. Also consider a good febrifuge.
- Decoction of wood also used as febrifuge.
- In Reunion, infusion of leaves used for sudorific effect, like coca leaves.
- In Ethiopia used for skin disease.
- In Peru, the sour and bitter leaves are chewed for its stimulant effect, like coca leaves.
- In Tamilnadu, leaves are used as poultice.
- In Martinique, the aromatics leaves and fruits are used in bath preparations, lotion used as astringent.
- Decoction used for flatulent colic and as purgative.
- In La Reunion, used for gout and rheumatism. Also, used in bath and fomentations.
- Powdered leaves are applied to burn and scalds.

In India, used for headaches, backaches, stomach pains, piles and simple ulcers. Leaves used in treatment of rheumatism, gout, hemorrhoids, fractures and snake bites. In Australia, used for wounds heal.

**Figure 1: Whole plant of *Dodonaea viscosa***


**Figure 2: Leaves of *Dodonaea viscosa***

**Figure 3: Flowers of *Dodonaea viscosa***

**Figure 4: Seeds of *Dodonaea viscosa***

**EARLIER PUBLISHED RESEARCH ON *DODONAEA VISCOSA***

1. Patel *et al*., researched about Candida albicans is developing resistance to existing drugs increasing morbidity and mortality, which elevates an immediate need to explore new antifungal agents. Phytochemicals are an excellent source of therapeutic agents. We previously reported the antifungal activity of the crude extract of *Dodonaea viscosa* var. angustifolia Jacq. (DVA) from which a beneficial compound flavone: 5, 6, 8-trihydroxy-7, 4′ dimethoxy flavone(5,6,8-trihydroxy-7-methoxy-2-(4-methoxyphenyl)-4H-chromen-4-one) abbreviated as TMMC, was extracted [11].
2. PPARγ agonists are widely used medications in diabetes mellitus therapy. Their role in improving adipose tissue function contributes to antidiabetic effects. The extracts of *Dodonaea viscosa* have been reported to exert antidiabetic activity. However, the effective mediators and the underlying mechanisms were largely unknown. In this study, we investigated the action on PPARγ transactivation and adipocyte modulation of two typical flavonoid constituents from D. viscosa, 5, 4'-dihydroxy-7, 8-dimethoxyflavanone and aliarin. Our results showed that 5, 4'-dihydroxy-7, 8-dimethoxyflavanone and aliarin were potential partial PPARγ agonists. The compounds induced adipogenesis in 3T3-L1 cells, with an upregulated adiponectin mRNA level and enhanced insulin sensitivity. The favorable effects of 5,4'-dihydroxy-7,8-dimethoxyflavanone, aliarin, and other flavonoid constituents on adipocytes might contribute to the anti-diabetic efficacy of D. viscosa [12].
3. *Dodonaea viscosa* (L.) Jacq (Sapindaceae) has been used in traditional medicine as antimalarial, anti-diabetic and antibacterial agent, but further investigations are needed. This study determines the antioxidant and anticholinesterase activities of six compounds (1-6) and two crystals (1A and 3A) isolated from *D.viscosa*, and discusses their structure-activity relationships. Antioxidant activity was evaluated using six complementary tests, i.e., β-carotene-linoleic acid; DPPH(•), ABTS(•+), superoxide scavenging, CUPRAC and metal chelating assays. Anticholinesterase activity was performed using the Elman method. Clerodane diterpenoids (1

and 2) and phenolics (3-6) - together with three crystals (1A, 3A and 7A) - were isolated from the aerial parts of *D. viscosa*. Compound 3A exhibited good antioxidant activity in DPPH (IC50: 27.44 ± 1.06 μM), superoxide (28.18 ± 1.35% inhibition at 100 μM) and CUPRAC (A0.5: 35.89 ± 0.09 μM) assays. Compound 5 (IC50: 11.02 ± 0.02 μM) indicated best activity in ABTS assay, and 6 (IC50: 14.30 ± 0.18 μM) in β-carotene-linoleic acid assay. Compounds 1 and 3 were also obtained in the crystal (1A and 3A) form. Both crystals showed antioxidant activity. Furthermore, crystal 3A was more active than 3 in all activity tests. Phenol 6 possessed moderate anticholinesterase activity against acetylcholinesterase and butyrylcholinesterase enzymes (IC50 values: 158.14 ± 1.65 and 111.60 ± 1.28 μM, respectively). This is the first report on antioxidant and anticholinesterase activities of compounds 1, 2, 5, 6, 1A and 3A, and characterisation of 7A using XRD. Furthermore, the structure-activity relationships are also discussed in detail for the first time [13].

4. It is widely known that hepatitis and its complications such as cirrhosis or hepatocellular carcinoma are one of the major health problems of the world especially since no specific treatment is available. In the present study we investigated the hepatoprotective potential of the methanolic extract of the whole plant of *Dodonaea viscosa* and its ethyl acetate, aqueous, butanol and n-hexane fractions against carbon tetrachloride ($CCl_4$) induced hepatoxicity in rats. Hepatoprotection was assessed in terms of reduction in serum enzymes (ALT, AST, and ALP) that occur after $CCl_4$ injury, and by histopathology and immunohistochemistry. The methanolic extract reduced the serum enzyme level (ALT, AST, and ALP) down to control levels despite $CCl_4$ treatment. It also reduced the $CCl_4$-induced damaged area to 0% as assessed by histopathology. The CD68+ macrophages were also reduced in number around the central vein area by the methanolic extract. These hepatoprotective effects were better than the positive control silymarin. Similar hepatoprotective activities were found with the ethyl acetate, and aqueous fractions of the methanolic extract. The butanol and n-hexane fractions showed elevated levels of ALT, AST and ALP as compared to the positive control silymarin. Histopathology showed ~30% damage to the liver cells with the butanol and n-hexane fractions which still showed some protective activity compared to the $CCl_4$ treated control. HPLC fingerprinting suggested that hautriwaic acid present in the methanolic extract and its ethyl acetate, and aqueous fractions may be responsible for this hepatoprotective activity of *Dodonaea viscosa*, which was confirmed by in vivo experiments [14].
5. The leaves of *Dodonaea viscosa* var. angustifolia (DVA) were used traditionally for the treatment of fever, colds, oral thrush, toothaches and related problems. Streptococcus mutans is implicated in many oral infections. This study investigated the inhibitory activity of DVA extract against Streptococcus mutans and its biofilm. The time-kill curve for Streptococcus mutans at different concentrations of methanol extract after 6 and 24 h was determined. Biofilms of Streptococcus mutans were grown in the presence of subinhibitory concentration of extract (0.78 mg/ml) for 30 h and the bacterial counts were obtained after 6, 24 and 30 h. The chemical profile of the crude extract was obtained using gas chromatography-mass spectrometry (GC-MS) [15].
6. Oily substances extracted by a crude process from the stem including its bark (hereafter referred to as the stem) of *Dodonaea viscosa* (L.) Jacq. had been used by practitioners of traditional Indian medicine to treat inflammation, pain and other musculoskeletal disorders. The aim of this study is to understand the scientific phenomena behind the process adopted by traditional practitioners for extraction and to establish the principle of extraction process by a simulated scientific method. The study also investigates the phyto-chemical composition of the extracts and compares the simulated extract with the traditional extract. The traditional method was subjected to a detailed analysis, and it was identified as a crude equivalent of pyrolysis. The process was simulated under controlled conditions in a self-fabricated prototype pyrolyser. The extracts from both methods were compared for their compositional identity and phytochemistry using FT-IR and GC-MS. The results show that in both the cases, the presence of dihydroxy, dimethyl and other substituted catechols, which are postulated as pyrolysate derivatives of the anti-spasmodic flavonoids quercetin, rutin, kaempferol and sakuranetin. The applied principle of extraction is identified as slow pyrolysis, which is supported by the visual and chemical similarities of the extracts from both methods. The phyto-chemical analysis indicates the presence of anti-spasmodic chemicals in the extract from the stem of *Dodonaea viscosa* (L.) Jacq.; these chemicals are likely the active substances in the treatment of inflammation, pain and other musculoskeletal disorders, and the research substantiates the stem's historical use by traditional practitioners [16].
7. *Dodonaea viscosa* Jacq., Sapindaceae, is a plant traditionally used as anti-fever, anti- rheumatic and antimicrobial. This work determined morpho-anatomical parameters, by macro and microscopic analysis of *Dodonaea viscosa* leaves, aiming to reach their diagnosis as pharmaceutical input. Macroscopically, the leaves have a lanceolate shape limb, full margin, rough consistence and venation eucamptodromous. The petiole is short, straight and in transversal section it is triangular with round angles. Microscopically, the lenticullar formation cuticle is seen with prominence, the glandular tricomes are seen with four cells on the base, the non-glandular unicellular tricomes are seen with pointed apex, the higrophitic stomatas are disposed in the lower surface epidermis only, the palisade parenchyma show up to three-cell layers and vascular bundles with xylem

involved by phloem and parenchyma lines which bound a central mass of parenchyma cells to a sclerenchyma sheath. This morph-anatomical characteristic, when analyzed in group, contributes to the botanical quality control of *Dodonaea viscosa* leaves as pharmaceutical input [17].

8. To study the effect and mode of action of water extract (DVW) and polar fraction of ethanol extract (DVE-4) of D. viscosa in high-fructose diet induced insulin resistance in male Wistar rats. D. viscosa's effects were evaluated on a battery of targets involved in glucose homeostasis (in vitro studies). Rats were rendered insulin resistant by feeding 66% (w/w) fructose and 1.1% (v/w) coconut oil mixed with normal pellet diet (NPD) for six weeks. DVW and DVE4 at different doses were administered simultaneously. At the end of the study, blood glucose, oral glucose tolerance test, lipid profile and insulin were estimated and homeostatic model assessment (HOMA) levels were calculated. In addition, enzymatic and nonenzymatic liver antioxidant levels were also estimated. Quantification of biomarker quercetin was done using HPLC. Fructose diet with DVW, DVE-4 significantly reduced blood glucose, serum insulin, HOMA, lipid profiles and significantly improved glucose tolerance and HDL-c levels. In addition, these extract and fraction also decreased oxidative stress by improving endogenous antioxidants. In different bioassays, DVW and DVE-4 inhibited protein tyrosine phosphatase-1B with IC50 65.8 and 54.9 microg/ml respectively and showed partial inhibition of dipeptidyl peptidase-IV. Moreover, DVW and DVE-4, at 10 microg/ml showed 60 and 54.2% binding to peroxisome proliferator-activated receptor-gamma. Further, 2.1% (w/w) of quercetin was quantified in bioactive-DVE-4 using HPLC method. The results provide pharmacological evidence of D. viscosa in treatment of prediabetic conditions and these effects may be mediated by interacting with multiple targets operating in diabetes mellitus [18].
9. The major extensively recommended treatments for anxiety and insomnia disorders are the benzodiazepines; yet, they have protuberant side effects. Consequently, the progress of new pharmacological agents is well acknowledged and so it is now contemporary to search some safe and effective alternative medicine. The current study was aimed to investigate the CNS effect of the stem bark of *Dodonaea viscosa* in experimental animal models. Preliminary phyto-chemical screening and Thin Layer Chromatography (TLC) of the ethyl acetate extract of stem bark of *Dodonaea viscosa* (EAEDV) were performed. Acute oral toxicity study was performed as per OECD 423 guidelines. The CNS effects were evaluated using Elevated Plus Maze (EPM) and phenobarbitone induced sleeping time using Diazepam (2 mg/kg) as the standard. Phyto-chemical analysis reflects the presence of flavanoids, alkaloids, terpenoids and tannins. The TLC studies confirmed that the isolated compound was found to be quercetin. Mortality and sign of any toxicity were not observed up to the dose orally with 2000 mg/kg. For all the statistical tests performed, $p< 0.005$ is considered to be significant [19].
10. The crude ethanolic extract and n-hexane, dichloromethane, ethyl acetate, nbutanol and aqueous fractions of *Dodonaea viscosa* were analyzed for antibacterial potential against four Gram positive bacteria: Bacillus subtilis, Bacillus cereus, Micrococcus luteus, Staphylococcus aureus, and three Gram negative bacteria: Escherichia coli, Salmonella typhi, Pseudomonas aeruginosa. Preliminary screening showed inhibition against Staphylococcus aureus, Micrococcus luteus, Escherichia coli and Pseudomonas aeruginosa. The thin layer chromatograms of the fractions were then subjected to contact bioautography, which showed inhibition zone at different Rf values against Bacillus subtilis, Micrococcus luteus, Escherichia coli, Salmonella typhi and Pseudomonas aeruginosa, indicating the presence of antibacterial components. The MIC of each fraction was determined through a 96-well micro-titer plate method. The non-viability of the organisms was ascertained by determining the MBC of the fractions [20].

Antimicrobial activity of solvent extracts of leaves and shoot of *Dodonaea viscosa* Jacq have been determined against fungi, Aspergillus niger, Aspergillus flavus, Paecilomyces varioti, Microsporum gypseum, and Trichophyton rubrum causing skin diseases. All crude extracts were found to be effective against tested fungi. However chloroform has strong inhibition activity against fungi as compared to ethanol, methanol, ethylacetate and aqueous extracts. More over in present study some basic elements have been analyzed, Al, Ca, Cu, Fe, Mg, Mn, P, S and Zn from the medicinal plant *Dodonaea viscosa* Jacq. by using atomic absorption spectrophotometry and UV spectrophotometry. The medicinal plant *Dodonaea viscosa* Jacq contains considerable amount of elements, which have therapeutic effects in skin diseases [21].

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